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Effects of Feeding OmniGen- AF® on Immune Function, Performance, and Carcass Characteristics during the Feeding Period

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Summary

OmniGen-AF (Phibro Animal Health, Quincy, IL) was fed to steers to evaluate the effects on the metabolic and immune response during an immune challenge, as well as feedlot performance. The inclusion of OmniGen-AF for either the first 28 d or the entire feeding period) did not impact feedlot performance or carcass characteristics. However, within a subset of cattle receiving an immune challenge (the endotoxin lipopolysaacharide; LPS), OmniGen-AF supplementation did alter the metabolic and immune profile of steers. These results suggest that feeding of OmniGen-AF may enhance the metabolic and immune response if cattle are challenged by bovine respiratory disease.

Introduction

Within the beef industry, one of the most prevalent diseases is Bovine Respiratory Disease (BRD). The major hurdle in overcoming BRD is the multi-factorial etiology of the disease. Bovine respiratory disease is a combination of stress, viral pathogens, and bacterial pathogens that interact to cause major economic losses due to morbid cattle. A potential strategy to aid in combating BRD could be the inclusion of OmniGen-AF. OmniGen-AF is a feed additive that is composed of active dried *Saccharomyces cerevisiae* in combination with other vitamins and minerals that may have the potential to enhance the immune function of cattle. OmniGen-AF is a patented proprietary product shown to augment the innate immune function in cattle. The purpose of this study was to evaluate differences in immune response, feedlot performance, and carcass merit of newly received calf-fed steers fed OmniGen-AF.

Procedures

Three hundred and six calf-fed steers (BW 581 ± 41 lb) were utilized in a randomized block design experiment at the University of Nebraska-Lincoln Agricultural Research and Development Center (ARDC) near Mead, Neb. Steers were received over two d period at the ARDC. Upon arrival, steers were provided access to water and were processed, weighed, and allocated to treatment within 12 hours. Steers were blocked based on arrival date resulting in two blocks. Within blocks, steers were assigned randomly to 36 pens and pens assigned randomly to treatment (8–9 steers/pen and 12 pens/treatment).

Treatments diets included: Control (CON; basal receiving diet, no OmniGen-AF); basal receiving diet with OmniGen-AF supplemented at 4 g/100 cwt/hd/d for the first 28 d on feed (OG+28); or OmniGen-AF supplemented at 4 g/cwt/hd/d for the entire feeding period (OG+EFP). OmniGen-AF was supplemented daily to steers through the diet supplement for—both OmniGen treatment groups. The receiving diet was 30% alfalfa hay, 30% dry rolled corn, and 36% Sweet Bran with 4% supplement added. After the receiving period, steers were limit-fed a diet (50% alfalfa hay, 50% Sweet Bran) at 2% of BW for 5 d before weighing for ending BW to minimize gut fill variation. Ending BW for the receiving period was an average of 2 d weights collected after limit-feeding. Steers were adapted to a common finishing diet by replacing alfalfa hay at 27.5%, 20%, 12.5%, 5%, and 0% with high moisture corn at 22.5%, 30%, 37.5%, 45%, and 50% of the diet DM for steps 1 through 5 of the ration. Sweet Bran was held constant 40% while wheat straw and supplement were both held constant at 5%. During the adaptation, heifers were on step 1 for three d, step 2 for four d, step 3 for seven d, step 4 for seven d, and step 5 was the finishing ration. The final finishing diet included 50% high moisture corn, 40% Sweet Bran, 5% wheat straw, and 5% supplement. At the conclusion of the 28 d receiving period, OmniGen+28 steers were switched to the CON diet (no OmniGen-AF), while OmniGen+EFP cattle continued to receive OmniGen-AF supplement; recalculated every 30 d to supply 4 g/cwt/hd/d of BW. Also, after the 28 d receiving period, all steers were implanted with Revalor® XS (Merck). During the last 28 d of the finishing period, all cattle were supplemented Optaflexx® (Elanco) for 28 d at 300 mg/hd/d. At the end of the trial, steers were transported to Greater Omaha Pack (Omaha, Neb.). The following morning steers were harvested at which time hot carcass weights (HCW) were recorded. Following a 48 h chill, fat thickness, rib eye area (REA), and USDA marbling score were determined. Final BW, ADG, and F:G were calculated using HCW adjusted to a common (63%) dressing percentage.

To evaluate the immune response, on d 25 of the receiving period, 18 steers (nine steers from CON (n = 9), and OmniGen-AF treatment groups (n = 9; 4 from OmniGen+28 and 5 from OmniGen+EFFP) treatment groups) from block 2 were randomly selected for an immune challenge and moved into a tie stall barn. After a 3 d adjustment period, steers were fitted with indwelling jugular vein catheters for serial blood collection and indwelling rectal temperature (RT) recording devices, programed to record RT at 5-min intervals. After insertion of the jugular catheter and RT device, steers were returned to the individual tie stalls and allowed to rest for the remainder of the d.

On the following d, from 0800 to 1800 h, blood samples were collected at 30 min intervals from 2 h prior to the challenge to 8 h after the challenge. At 1000 (0 h), following the collection of the blood sample, steers were administered an i.v. bolus of

lipopolysaccharide (LPS, 0.5 µg/kg BW; *E. coli* O111:B4). At each collection point, 9 mL of blood was collected via monovette tubes for serum. After collection, blood samples were allowed to clot for 30 min at room temperature, centrifuged at 2,000 x *g* for 30 min (39.2°F) and serum was separated. Serum was collected and transferred into 1.5 mL microcentrifuge tubes and held at-112°F until analyzed for cortisol, pro-inflammatory cytokines (Tumor Necrosis Factor-α; TNF-α, Interferon-γ; IFN-γ, and Interleukin-6; IL-6), blood urea nitrogen (BUN), non-esterified fatty acids (NEFA), and glucose.

Feedlot performance data were analyzed as a randomized block design using MIXED procedures of SAS (SAS Institute, Inc., Cary, NC). Steers were blocked by arrival date and pen was the experimental unit; model included the fixed effect of treatment and block was a random effect. Immune response data were analyzed as a completely randomized design with repeated measures using the MIXED procedures of SAS; model included fixed effects of treatment and time, treatment × time was used as the error term to test whole plot effect. For both feedlot and immune data, when results of F-test were significant ($P < 0.05$), group means were compared by use of least significant difference. Pair wise differences among least squares means at various sample times were evaluated with the PDIFF option of SAS. Distribution of USDA Quality Grade data were analyzed as a randomized block design using the GLIMMIX procedure of SAS.

Results

At the conclusion of the receiving period (28 d), ending BW ($P = 0.43$), DMI ($P = 0.76$), ADG ($P = 0.32$), and F:G ($P = 0.35$) were similar between treatments. While overall rate of morbidity was low, there was a trend ($P = 0.12$) for morbidity to be decreased in OmniGen+28 and OmniGen+EFP steers when compared to CON steers. At the conclusion of the finishing period, no difference in final BW (P = 0.59), DMI ($P = 0.89$), ADG ($P = 0.66$) or F:G ($P = 0.90$) were observed across the three dietary treatments (Table 1). In regards to carcass merit, there were no differences in weight or characteristics (P > 0.31). There was no difference in the percentage of USDA Prime, USDA Choice, or USDA Select Quality Grades for all three dietary treatments. These data suggest that including OmniGen-AF during the receiving period (28 d) or for the entire feeding period does not impact feedlot performance or carcass merit of calf-fed steers.

For the LPS challenge portion of the trial, there was a dietary treatment ($P = 0.002$) and time effect ($P = < 0.001$); however, there was no dietary treatment x time interaction ($P = 0.99$) for RT. Steers within the OmniGen-AF treatment groups had a greater ($P < 0.01$) RT when compared to CON steers (102.70 ± 0.02°F vs. 102.51 ± 0.02°F, respectively). For both groups of steers, maximum RT was observed 2.5 h post LPS administration, and within 6 h, RT had returned to baseline temperatures (Figure 1.). Prior to the LPS challenge, RT was greater in the OmniGen-AF steers when compared to CON steers. Due to this difference prior to challenge, RT data were analyzed as the change in RT from baseline. As a change from baseline, RT was similar ($P = 0.49$) between the treatment groups.

For serum concentrations of cortisol, there was a dietary treatment effect ($P = 0.005$) whereby OmniGen-AF steers had decreased cortisol concentrations when compared to the CON steers (Table 2). Cortisol is the primary hormone responsible for the stress response. During an immune challenge, aside for initiating the bodies response to the stress (immune challenge) the release of cortisol also serves to prevent hyper-inflammation. There was a dietary treatment effect ($P = 0.03$) for the pro-inflammatory cytokines TNF-α

Table 1. Receiving period and overall feedlot performance and carcass merit for steers fed no OmniGen-AF (CON), OmniGen-AF during the receiving period (OmniGen+28), or OmniGen-AF for 215 d (OmniGen+EFP)

Item	Treatment groups[a]			SEM	*P-value*
	CON	OmniGen 28	OmniGenEFP		
Receiving Performance					
Initial BW, lb	571	573	577	7.0	0.82
Ending BW, lb[b]	662	670	675	8.0	0.43
DMI, lb/d	16.5	17.0	16.8	0.80	0.76
ADG, lb[c]	3.18	3.38	3.48	0.33	0.32
Feed:Gain[d]	5.53	5.00	5.24	—	0.35
Morbidity, %[e]	6.9	2.0	3.0	3.0	0.12
Feedlot Performance					
Initial BW, lb	662	670	675	6.0	0.87
Final BW, lb[f]	1431	1416	1417	11.0	0.59
DMI lb/d	21.6	21.6	21.8	0.3	0.89
ADG lb/d[g]	3.91	3.92	3.93	0.04	0.66
Feed:Gain	5.55	5.51	5.56	—	0.90
Carcass Merit					
HCW, lb	901	892	893	7.0	0.96
LM area, in^2	14.7	14.2	14.6	0.25	0.31
Calculated YG	3.1	3.3	3.1	0.14	0.52
12th rib fat, in.	0.5	0.6	0.6	0.14	0.86
Marbling[h]	503	498	508	24.0	0.96
Prime (%)	4.5	2.1	5.3	2.32	0.53
Choice (%)	76.4	76.6	81.9	4.50	0.59
Select (%)	19.1	21.3	13.8	4.22	0.41

[a]CON: No OmniGen-AF; OMN-28: OmniGen-AF during receiving, OMN-EFP: OmniGen for 215 d (the entire feeding period).
[b]Limit fed at 2% of BW for 4 d prior to single BW to determine ending BW of receiving period
[c]Calculated from ending BW of receiving period
[d]Analyzed as G:F, the reciprocal of F:G.
[e]Overall percentage of steers treated for bovine respiratory disease
[f]Calculated from carcass weight, adjusted to 63% common dressing percent.
[g]ADG for the entire feeding period (including receiving period)
[h]Marbling Score: 400 = Small, 500 = Modest, etc.

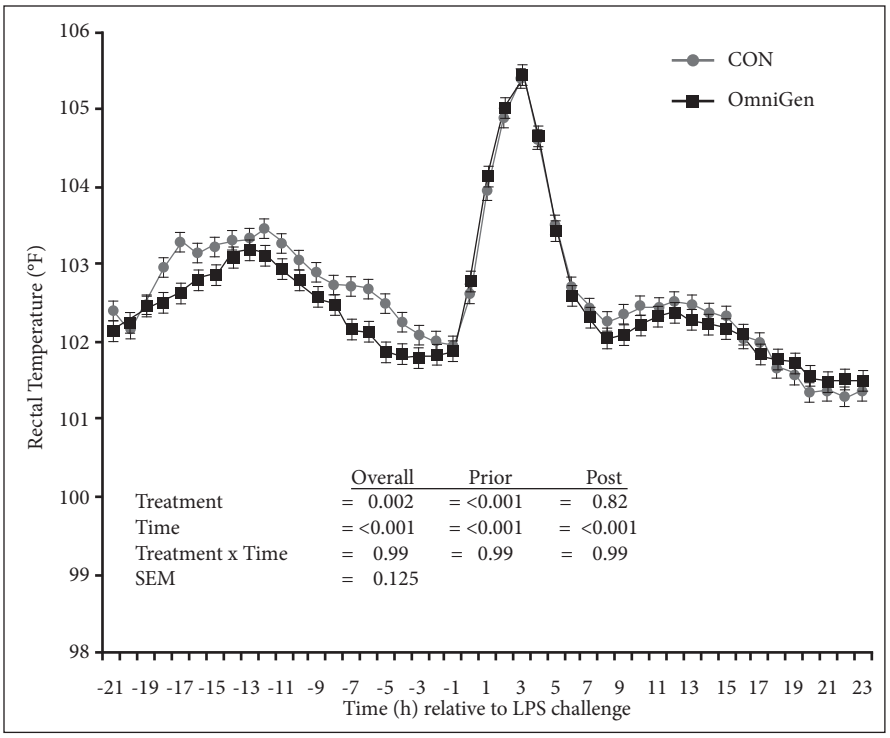

Figure 1. Rectal temperature of newly received steers supplemented OmniGen-AF at a rate of 4 g/cwt/hd/d (OmniGen) during the receiving period (28 d) or no OmniGen-AF (CON) during a lipopolysaccharide challenge

and IFN-γ (Table 2). Concentrations of TNF-α and IFN-γ were greater ($P = 0.03$) in OmniGen-AF steers when compared to the CON steers. Concentrations of IL-6 were not impacted ($P = 0.87$) by dietary treatment. Pro-inflammatory cytokines are released as a first response to an immune challenge; initiating a cascade of the immune response, such as inducing fever, inflammation, and initiating the healing of damaged tissue. The increased production of TNF-α and IFN-γ, may indicate the OmniGen-AF fed steers were able to mount a more robust pro-inflammatory response, compared to the CON steers.

Blood urea nitrogen (BUN), non-esterified fatty acids, and glucose were analyzed to evaluate metabolic alterations during the LPS challenge. Steers within the CON treatment group had greater ($P < 0.01$) concentrations of BUN and NEFA when compared to the OmniGen-AF steers (Table 2). Serum glucose concentrations were greater ($P < 0.01$) for OmniGen-AF fed steers, when compared to CON steers (76.42 ± 1.1 mg/mL vs. 72.42 ± mg/mL, respectively; Table 2). Both BUN and NEFA are indicators of energy mobilization; this increase in both BUN and NEFA may indicate a greater need for energy from CON steers to mount an immune response when compared to OmniGen-AF steers.

Overall, the results of this study indicate that the feeding of OmniGen-AF to calf-fed steers did not impact feedlot performance or carcass merit, but did alter the metabolic and immune response of calf-fed steers during an LPS challenge. While there was a decreased rate of morbidity in both treatments, the trend in decreased receiving morbidity in the OmniGen-AF fed steers may be a result of the alterations observed in the LPS challenge (decreased energy metabolism and increased pro-inflammatory cytokines). Overall, these alterations associated with OmniGen-AF feeding may allow for an enhanced metabolic and immune response of newly received cattle, which may help cattle combat BRD.

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Table 2. Endocrine, immune, and metabolic analysis of newly received steers supplemented OmniGen-AF at a rate of 4 g/cwt (OMN) during the receiving period (28 d) or no OmniGen-AF (CON) during a lipopolysaccharide challenge (LPS)

	Treatment groups[a]		SEM	Trt	Time	T × T
	CON	OmniGen				
Overall Cortisol	29.22	25.52	4.44	0.05	< 0.001	0.99
Post-LPS[b]	34.74	30.07	1.15	0.004	< 0.001	0.99
Overall TNF–α[c]	12.85	25.94	3.97	0.03	< 0.001	0.42
Post-LPS	15.71	31.04	4.88	0.03	< 0.001	0.47
Overall IFN–γ[d]	0.76	1.85	0.21	0.003	< 0.001	0.77
Post-LPS	0.93	2.12	0.26	0.007	< 0.001	0.81
Overall IL-6[e]	1877.66	1849.28	697.75	0.87	< 0.001	0.99
Overall BUN[f]	12.44	11.47	0.12	< 0.001	0.28	0.99
Overall NEFA[g]	0.21	0.10	0.01	0.002	< 0.001	0.49
Overall Glucose	72.42	76.36	1.12	0.009	< 0.001	0.19
Post-LPS	69.72	74.23	1.28	0.009	< 0.001	0.23

[a]CON = basal receiving diet (No OmniGen), OmniGen = OmniGen-AF at a rate of 4 g/cwt for 28 d. For the OmniGen treatment group; 4 steers from the OmniGen+28 group and 5 steers from the OmniGen+EFP were utilized)
[b]Treatment means after the LPS challenge (0.5–24 h)
[c]Tumor necrosis-α
[d] Interferon-γ
[e]Interleukin-6
[f]Blood urea nitrogen
[g]Non-esterified fatty acids